A.D. 1878. July 20. N° 2908.
CLARK'S Provisional Specification.

(1 SHEET)

FIG. 1.

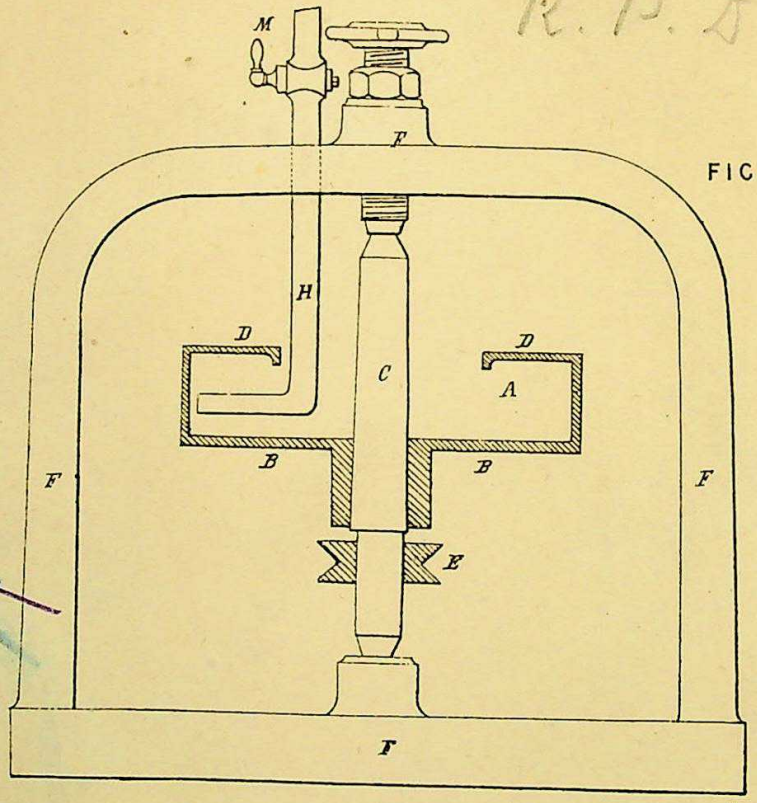


FIG. 2.

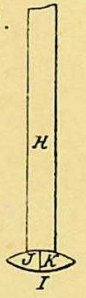


FIG. 3.

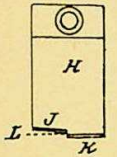


FIG. 5.

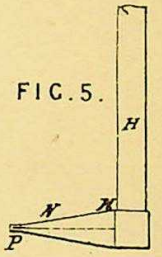
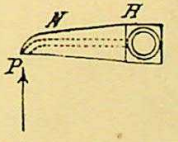


FIG. 4.



Malby & Sons, Photo-Litho.

A.D. 1878. JULY 20. № 2908.
CLARK'S SPECIFICATION.

Class 103-PUMPS.
Rotary Single Piston

Centrifugal 2908 of 1878.

con. w. receiver in which it is desired to create vacuum, or (water introduced) it rotated in op. direction water will be raised in it.

FIG. 1.

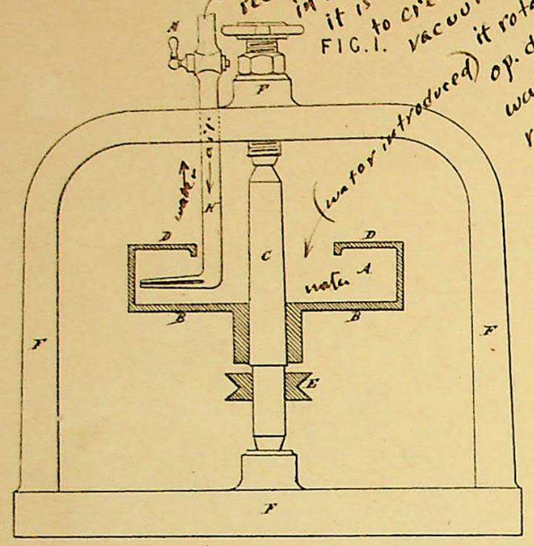


FIG. 6.

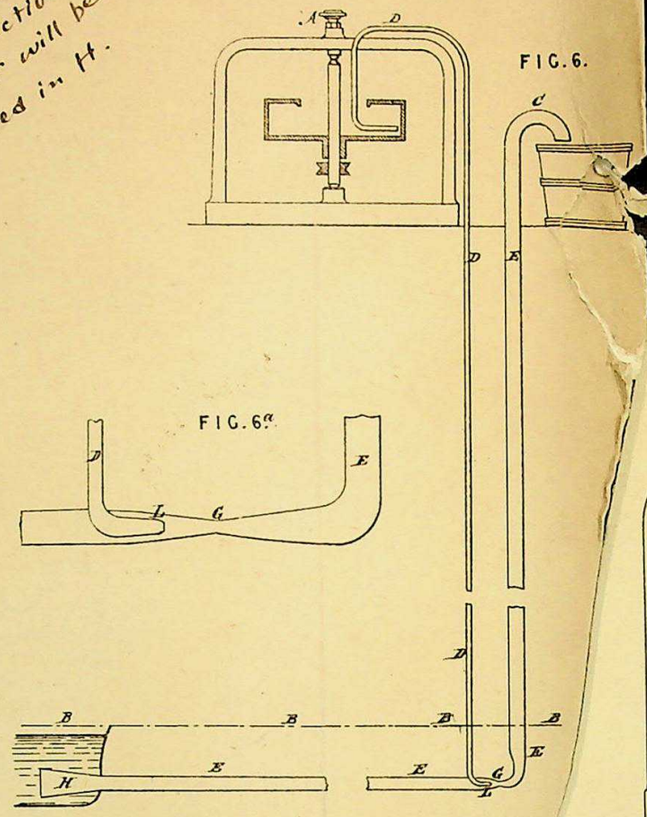
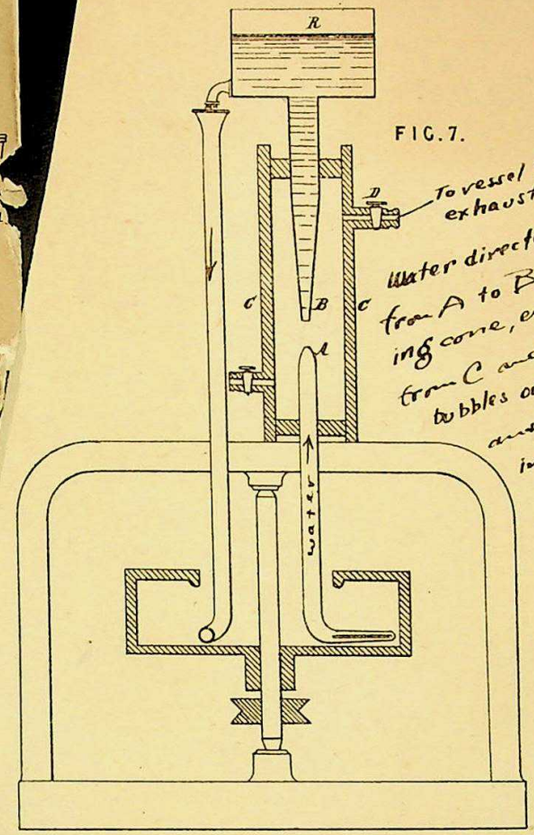


FIG. 6a.

FIG. 7.



To vessel to be exhausted

Water directed in jet from A to B, the receiving cone, entraining air from C and vessel. Air bubbles out from R and water falls into pump

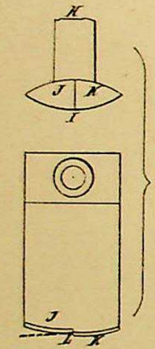


FIG. 2.

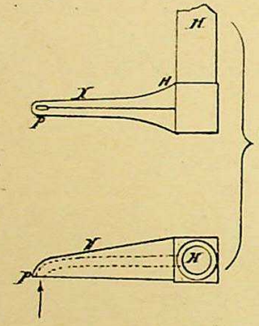


FIG. 3.

FIG. 4a.

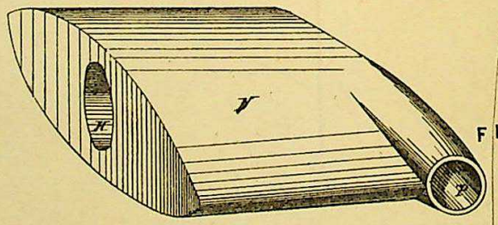


FIG. 4.

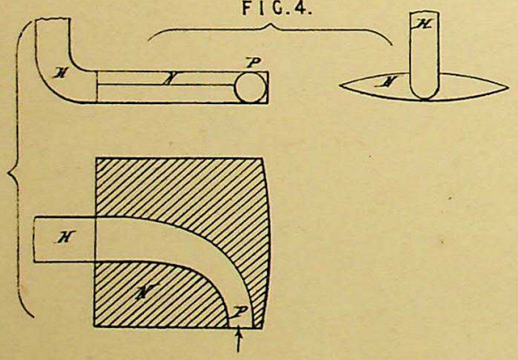


FIG. 5.

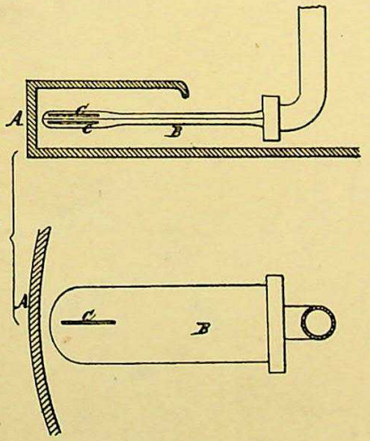
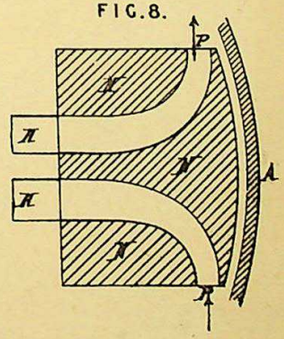


FIG. 8.



Malby & Sons, Photo-Litho

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE
Printers to the Queen's most Excellent Majesty. 1879

A.D. 1878, 20*th* JULY. N° 2908.

Apparatus for Exhausting and Forcing Fluids.

LETTERS PATENT to Alexander Melville Clark, of Chancery Lane, in the County of Middlesex, Patent Agent, for the Invention of "IMPROVEMENTS IN APPARATUS FOR EXHAUSTING AND FORCING FLUIDS." A communication from abroad by Henri Félix Louis Worms de Romilly, of Paris, France.

Sealed the 20th September 1878, and dated the 20th July 1878.

PROVISIONAL SPECIFICATION left by the said Alexander Melville Clark at the Office of the Commissioners of Patents on the 20th July 1878.

ALEXANDER MELVILLE CLARK, of Chancery Lane, in the County of Middlesex, Patent Agent. "IMPROVEMENTS IN APPARATUS FOR EXHAUSTING AND FORCING FLUIDS." [A communication from abroad by Henri Félix Louis Worms de Romilly, of Paris, France.]

The improved machine of this Invention consists of a rotary drum containing a liquid which is carried round by a drum in its rotation, and a stationary pipe terminating in a branch having an orifice of peculiar shape, which is immersed in the liquid in said drum near its circumference, and in which pipe a fluid is exhausted or forced, or both, according to the direction of motion of the liquid in the drum relatively to the said orifice and the construction of the pipe as hereafter described.

In order that the Invention may be more readily understood, I will describe it in detail with reference to the accompanying Drawing, in which it is illustrated by way of example only.

A, Figure 1, is the drum in the form of a short, hollow, right cylinder closed at bottom and mounted axially upon a spindle C, passing through a central boss on the bottom B, turning on coned centres in a strong fixed frame F. An opening is left around the spindle C, which forms a kind of inwardly projecting circular flange or rim to prevent the liquid being thrown out of the drum by centrifugal action. The inside edge of this rim D is also provided with a downardly projecting lip to prevent splashing.

[*Price* 6*d.*]

The drum is driven from a suitable motor, either by a belt or spur gearing applied to a pulley E or a toothed wheel or cone keyed on spindle C.

H is a pipe parallel to the spindle C and fixed to the frame F, and projecting into the drum A. The tube H is bent at a right angle, and then extends radially close up to the circumference of the drum. This branch of the pipe is flattened to the lenticular form in cross section, shown at I, Figure 2, the two opposite acute angles being in a line forming a chord to the circumference of the drum. Two partition plates J, K, Figures 2 and 3, extend from these opposite angles to the middle of the width of the tube, and terminate in a line parallel to a generatrix of the cylinder or drum. These two plates are curved somewhat to the circular form of the cylinder, but to a rather smaller radius than if they were concentric therewith. The meeting line of the two divisions is thus the nearest point to the circumference of the drum, and the one plate K is set slightly nearer this circumference than the other, so that where the two plates meet, or rather nearly meet, a linear orifice L is formed in the shape of an elongated rectangular slit parallel to the axis and in a plane passing through said axis. As the two divisions terminate in the same median line, the linear orifice will only give passage in or out to a jet of liquid or gaseous fluid tangential to the curve of the extremity of the tube.

The other end of pipe H is either connected to a receiver in which it is required to create a vacuum, or put in communication with the fluid (liquid or gaseous) to be exhausted through the linear orifice.

The following is the action :—A certain quantity of water is first placed in the drum, which is then revolved in such direction that the water carried round therewith shall first pass over the partition plate nearest the circumference; then over the other, and thus produce a small cataract. If the pipe be in communication with an air-tight vessel provided with a vacuum gauge, a vacuum will be seen to gradually form; this vacuum is a function of the velocity of rotation of the drum.

By closing cock M, Figure 1, the vacuum may be maintained after the machine ceases to work; or it may be maintained by keeping the machine in motion.

Instead of the machine being used to create a vacuum, it may be made in a similar manner to exhaust a gas or liquid.

By rotating the cylinder in the reverse direction so as to cause the water to first pass over the division farthest from the circumference of the drum, the water will be made to enter the pipe H, and the gauge will now indicate a pressure increasing as the square of the speed of the drum.

If the receiver be provided with an orifice, or the pipe terminates directly in the open air, the water will flow out therefrom at a velocity which is a function of the speed of rotation, and of the height to which the water is raised in the pipe before it escapes, due allowance being also made for the difference in the size of the inlet and outlet orifices, and also for friction bends in the pipes, &c.

The extremity of the branch pipe may also be made of the flattened form shown at N, Figures 4 and 5, so as to present a minimum resistance to the circulating current of water, the orifice P being normal to the direction of the water, the form of the orifice being in this case much more simple.

The part of the tube perpendicular to a generatrix of the cylinder is tapered or flattened so as to resemble a double-edged blade, and in one of its lateral edges near the point a slit P is made, which is radial, and presented directly to the affluent water in the cylinder or drum.

The sides of the orifice and also the immersed portion of the tube should be as reduced in thickness as possible so as to present little resistance to the water. This form of orifice may be used for exhausting as well as for forcing fluids.

The orifice may also be placed both in the one case and the other radially on the top or bottom side of the branch pipe.

By having two orifices on the same tube, opposite one another, and separated by a longitudinal partition, the apparatus may be used both for exhausting and forcing a gaseous or liquid fluid.

In the case of a liquid, the forcing is effected at that portion of the divided

tube at which the liquid enters, and the exhaustion takes place at the opposite side. Thus the liquid exhausted, instead of being immediately forced, has time to acquire sufficient speed during its circular motion in the drum before it arrives at the orifice through which it is to be forced.

In the above example I have spoken of but one exhausting and forcing pipe, but it will be understood that several may be used in the same drum.

In cases also where it is desired to both lift and force by the same drum, two of these may be placed concentrically, one in the other, upon the same spindle; the two drums would communicate and the suction would take place in the smaller turbine and the forcing in the larger one, in cases where it is desired to raise water to a great height.

The liquid employed for exhausting is usually water, but mercury, oil, brine, &c., may be used, according to circumstances.

One or more small turbines driven from spindle C may be specially employed for producing a circulation of oil for lubricating the moving parts.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Alexander Melville Clark in the Great Seal Patent Office on the 20th January 1879.

ALEXANDER MELVILLE CLARK, of Chancery Lane, in the County of Middlesex, Patent Agent. "IMPROVEMENTS IN APPARATUS FOR EXHAUSTING AND FORCING FLUIDS." A communication from abroad by Henri Félix Louis Worms de Romilly, of Paris, France.

The improved apparatus of this Invention consists of two distinct parts, *viz*., 1st, a rotary drum containing a liquid which is carried round by the drum in its rotation; and 2nd, a stationary pipe terminating in a branch having an orifice of peculiar shape, which is immersed in the liquid in said drum near its circumference, and in which pipe a fluid is exhausted or forced (or both), according to the construction of the pipe, and to the direction of motion of the liquid in the drum relatively to the said orifice as hereafter described.

The above describes in general terms the nature of the Invention, but in order that it may be more readily understood, I will describe it in detail with reference to the accompanying Drawing, in which it is illustrated by way of example only.

I.—THE DRUM.

In Figure 1 A is the drum in the form of a short, hollow, right cylinder closed at bottom and mounted axially upon a spindle C which passes through a central boss on the bottom B and turns on coned centres in a strong fixed frame F. An opening is left in the top of the drum around the spindle C, so as to form a kind of inwardly projecting circular flange or rim D to prevent the liquid being thrown out

of the drum by centrifugal action. The inside edge of this rim D is also provided with a downwardly projecting lip to prevent splashing.

The drum is driven from a suitable motor, either by a belt or spur gearing applied to a pulley E, toothed wheel or cone keyed on spindle C.

II.—The Exhausting and Forcing Apparatus.

(*a*). Exhausting.—H is a pipe fixed to the frame F; this pipe is parallel to the spindle C, and projects into the drum A at about the middle of the height of the drum. The tube H is bent at a right angle and then extends radially or in a direction perpendicular to the drum's axis close up to the circumference of the drum. This arm of the pipe is flattened to the lenticular form in cross section, shown at I, Figure 2, the two opposite acute angles being in a line forming a chord to the circumference of the drum. Two plates J, K, Figure 2, extend from these opposite angles to the medium line of the tubular arm and terminate in a line parallel to a generating line of the cylinder or drum. These two plates are curved to a rather smaller radius than if they were concentric therewith. The meeting line of the two plates is thus the nearest point to the circumference of the drum, and the one plate K is set slightly nearer this circumference than the other, so that where the two plates meet or rather nearly meet, a linear orifice L is formed in the shape of an elongated rectangular slit parallel to the axis of the drum, and in a plane passing through said axis. As the two plates terminate in the same median line, the linear orifice will only give passage in or out to a jet of liquid or gaseous fluid in a direction tangential to the curve of the extremity of the tubular arm.

The pipe H is either connected at the other end to a receiver, in which it is required to create a vacuum, or put in communication with the fluid (liquid or gaseous) to be exhausted through the linear orifice of the tubular arm above mentioned.

The following is the action:—A certain quantity of water is first placed in the drum, which is then revolved in such direction that the water carried round therewith shall first pass over the plate K nearest the circumference, and then over the other plate J, and thus produce a small cataract across the linear orifice between the two plates. If the pipe H be in communication with an air-tight vessel provided with a vacuum gauge, a vacuum will be seen to gradually form; this vacuum is a function of the velocity of rotation of the drum.

By closing cock M, Figure 1, the vacuum may be maintained after the machine ceases to work, or if the vacuum tends to become destroyed, it may be maintained by keeping the machine in motion.

Instead of the machine being used to create a vacuum it may be made in a similar manner to exhaust a gas or liquid.

The tubular arm may also be of the flattened form shown in Figure 5, and the slit in it may be radial to the axis of the drum; there may be a slit in one or both of the broad flattened surfaces of the arm. This slit should always have the edge over which the water first passes more projecting or farther than the other from a plane parallel to the base of the drum and passing through the centre of figure of the tubular arm, which at this point resembles a broad double-edged sword blade having near its extremity a longitudinal slit. The position of the slit may however be varied considerably, as will be readily understood without altering the principle.

In Figure 5 A is the side of the drum; B is the tubular arm flattened so as to have two opposite acute edges; and C are the exhaust slits or apertures in the upper and lower sides of said arm.

(*b*.) Forcing Fluids.—Referring again to Figures 1 and 2, if the drum be rotated in the reverse direction, so as to cause the water to first pass over the plate farthest from the circumference of the drum, the water will be made to enter the pipe H, and the gauge will now indicate a pressure increasing as the square of the velocity of the drum.

If the receiver be provided with an orifice, or if the pipe terminates directly in the open air as in the case of fire or garden hose, the water will flow out therefrom at a velocity which is a function of the speed of rotation, and of the height to which the water is raised in the pipe before it escapes, due allowance being also made for the difference in the size of the inlet and outlet orifices, and also for friction, bends, and other obstructions in the pipes, &c.

The extremity of the tubular arm may also be made of the flattened form shown at N, Figures 3 and 4, so as to present a minimum resistance to the circulating current of water, the orifice P being normal to the direction of the water.

The part of the tube perpendicular to a generating line of the cylinder is tapered or flattened so as to resemble a double-edged blade, as shown in perspective in Figure 4ª, and in one of its lateral edges near the extremities an orifice P is made, which is thus presented directly to the affluent water in the cylinder or drum.

From the orifice P the cross sectional area increases in the form of a cone of 6° for a distance equal at least to ten times the diameter of the said orifice.

The sides of the orifice and also the immersed portion of the tube should be as reduced in thickness as possible, so as to present the minimum amount of resistance to the water. This form of orifice may be used for exhausting as well as for forcing fluids.

As regards the ascension pipe H, it may be advantageous in forcing liquids to cut the pipe across, as on the one hand the velocity of rotation of the drum tends to force the water in it through the orifice, and as on the other hand the gravity of the column of water in the pipe tends to force the water in the opposite direction, there is a retardation in front of the orifice due to the opposition to the water circulating at full speed of the water passing through the orifice at a lower speed.

In order to reduce to a minimum the resistance within the drum, the ascension pipe should be cut across normally to its axis so as to leave just above the drum an interval or break in the pipe which will not obstruct the discharge of the jet of water if very short, and if the two adjacent openings of the pipe are of equal diameter, and if the one which discharges the water into the other is in the form of 30°, and if the other which receives the water is a cone of 6° the two cones having their smaller ends or bases opposite one another. By this means the resistance due to the ascending column will take effect at the interval or break, *i.e.*, at the orifice of the receiving cone. At this point a portion of the water will be rejected and overflow, thus showing the obstruction which would have existed if the break were not made in the pipe. This break may either be outside or inside the drum, but out of contact with the water circulating therein. This overflow water may be conveyed back to the drum by a pipe leading in the direction in which the drum is rotating, so as to avoid loss of power.

The drum is not necessarily located at the level B of the water to be raised, but may be placed at any higher level to which the water is to be raised. This is illustrated in Figures 6 and 6ª, in which the water propelled or forced by the action of the drum A, instead of ascending descends through pipe D to a larger horizontal pipe E located below the level B. The extremity of pipe D enters pipe E and is curved until it coincides with the axial line of pipe E, and terminates in a nozzle L from which the water is projected in the form of a jet. In front of this jet nozzle there is a receiving cone or orifice G of larger diameter varying according to the quantity of water to be carried along by the jet. This receiving cone G is formed on the tube E itself, which from the point of smallest diameter opposite the jet nozzle becomes gradually larger in the form of a cone of about 6°, and of a length equal to ten times the smallest diameter until the tube E finally regains its normal size and then ascends to the level of the drum, or higher still if necessary.

Behind the elbow of the jet pipe D and in the opposite direction to the jet the pipe E may be carried horizontally for a considerable distance to the supply of water to be raised. It terminates therein by a slightly flared or conical mouth H. The advantage of this horizontal portion of the pipe is that there is thus a long column of water in motion, which at the point where the impulse of the jet takes

effect has only to acquire an increase of velocity instead of moving from a state of repose.

As regards the jet itself it may in theory be considered to acquire beyond the initial velocity due to the action of the drum, a still higher velocity due to its fall, which alone is sufficient to raise it again to its normal level, and thus its initial velocity acts with undiminished effect on the water to be raised.

The tube E may either be below the level B or descend into the water from a higher level, in which case the tube must be otherwise exhausted at starting until the water rises above the level of the jet. The drum may thus be placed at the higher level, which would be very suitable in mines or at the lower or any intermediate level.

The same system of exhaustion by a water jet may be used for forming a vacuum as follows:—Referring to Figure 7, C is a closed chamber communicating by a tube D provided with a stop-cock with the vessel or chamber in which the vacuum is to be created. A is a jet nozzle on the pipe leading up from the drum as before, and B is a receiving cone of larger diameter than A in the same axial line therewith and at a distance therefrom, both A and B being enclosed in chamber C. Owing to the constant velocity with which the water ascends the jet may be directed upwards vertically or at an angle from the nozzle A to the receiving cone B, in which the water is held up by the velocity of the jet; into this water contained in the receiving cone the jet is projected, carrying along with it air which becomes entangled with the jet in passing across from A to B. Once this air mixes with the water held up in the cone B it is impossible for it to return to the chamber from which it has come, as it is compelled to ascend both by the difference of density and by the upward flow of the water itself in the receiving cone B. The air therefore rises and escapes from the surface in bubbles which decrease in number as the vacuum becomes more perfect.

The water may either overflow from the receiving cone B or be received in a cistern R above, and thence descend again to the drum, as shown, to be again used as before, so that the same water can be used indefinitely; or the pipe may lead back directly from the upper end of the receiving cone B (which is enlarged) to the drum.

The jet of water may either be cylindrical or flat so as to present a comparatively larger surface of contact with the air, the nozzle in that case having a linear orifice or slit; the jet may also be of annular form.

The orifice of the receiving cone corresponds in all cases with that of the jet nozzle.

The latter may either be single, as above described, or multiple, that is to say, form several jets, or several nozzles may be juxtaposed and arranged side by side either in one or more straight lines, or in a circle or concentric circles.

A separate receiving cone may be provided for each jet, or a single cone may receive the whole of the jets provided it is so arranged as not to leave between the jets as they are received in it so much space as to prevent the water being held up in the receiving cone.

The same arrangement may be used with mercury or other liquid, allowance being made as regards the power used for the density of the liquids, and as regards the material of which the apparatus is made for their chemical properties. When the liquid has reached the cistern above the receiving cone it may be treated in any suitable way before being returned to the drum, thus mercury if used might be constantly dried and purified if necessary.

It will be understood that the water raised by the drum may be used for a water-blowing engine, if desired.

Combined Forcing and Exhausting Apparatus.

By having two orifices at opposite sides of the same tubular arm, divided by a longitudinal partition into two separate thoroughfares, the apparatus may be used both for exhausting and forcing a gas or liquid.

In the case of a liquid the forcing is effected in that portion of the divided tube at which the liquid enters and the exhaustion takes place at the opposite side, the arrangement being, as in Figure 8 for example, which is a horizontal section through the two orifices, A being the side of the drum; N, the solid end of the tubular arm; P, P, the orifices; and H, the tubular passages, diminishing in diameter towards the orifice as a cone of 6°. Thus the liquid exhausted instead of being immediately forced has time to acquire its full velocity during the circular motion in the drum before it arrives at the orifice through which it is to be forced.

In the above examples one exhausting or forcing pipe only has been described, but it will be understood that several may be used in the same drum.

Where it is desired both to exhaust and to force by the same apparatus, two drums may be placed concentrically, one in the other, upon the same spindle, the two drums would communicate and the suction would take place in the smaller turbine, and the forcing in the larger one, in cases where it is desired to raise water to a great height.

The liquid employed for exhausting is usually water, but mercury, oil, brine, &c., may be used according to circumstances.

The cone centres of the drum spindle are lubricated in the ordinary way.

One or more small lubricators or oil turbines driven from spindle C may be specially employed for producing a circulation of the oil over the bearing surfaces.

The foot step bearing of the drum spindle if vertical may have an oil reservoir from which the oil is drawn up by centrifugal action and enters slits made in that part of the cone centre which bears in the foot step.

The jet of water obtained as herein described may be applied to any purpose for which water in motion can be used, for example, for propelling ships by applying it in the manner described in the Specification of a Patent granted to me bearing date 18th July| 1878, No. 2871, in which case instead of air or steam acting intermittently, the drum continuously exhausts and forces the water employed for propulsion.

Having described the nature of the Invention, and the manner of performing the same, I declare that what I claim as the Invention to be protected by the herein-before in part recited Letters Patent is,—

1st. The exhausting and forcing apparatus substantially as specified, consisting essentially (*a*) of a drum or cylinder having rotary motion, fixed by one of its bases or ends on a spindle, the other base or end being open and in form of a simple rim to retain the liquid, and (*b*) of a stationary tube projecting into the drum and having an orifice facing the direction in which the liquid is carried round, for forcing, or at the opposide side for exhausting, the other end of the tube being carried to the point to which the liquid is to be raised, or whence the liquid or gas is to be exhausted.

2nd. The flattened form of the part of the tube immersed in the drum so as to offer but little resistance as described.

3rd. The arrangement of apparatus in which the drum is placed at the level to which the liquid is to be raised from a lower level, by means of a jet nozzle entering an ascension tube, having a receiving cone opposite the nozzle, and prolonged behind the nozzle to the source of supply, in order to utilize the weight of the liquid in motion arriving at the point where the jet acts on this liquid in order to impart to it a portion of its velocity, as specified.

4th. The exhaustion produced by the liquid circulating in the tube and over the tube stationary therein, and provided with a slit or orifice either radial or parallel to a generating line of the cylinder or drum, the tube being flattened in the form offering least obstruction to the circulation of the liquid.

5th. The interval or break in the ascension pipe just above the drum, in order to relieve it of the resistance of the ascending column of liquid, as specified.

6th. The employment, for creating a vacuum or exhausting gases, of the apparatus

giving a continuous jet projected upwards from a nozzle into a receiving cone of larger diameter in which the liquid is held suspended and receives from below the jet mixed with air or gas entangled with it, which air or gas escapes whilst the liquid returns to the drum, all as specified.

7th. The simultaneous exhaustion and forcing of liquids in the same apparatus by means of a drum and a divided or double tube having two oppositely directed orifices, as herein specified.

8th. The employment of small turbines placed in the same shaft for lubricating the working parts.

9th. The employment of any liquid in the drum of the apparatus of this Invention for producing the effects above described.

10th. An apparatus consisting of a single drum with a number of tubes therein, similar to that herein described, as specified.

11th. The employment of two concentric drums constructed in one or separately, but on the same axis, in combination each with a tube projecting therein as described for simultaneously exhausting and forcing, as specified.

12th. The application of the herein-described apparatus and of the jet of water which it produces for propelling ships and other purposes generally.

In witness whereof, I, the said Alexander Melville Clark, have hereunto set my hand and seal, this Twentieth day of January, in the year of our Lord One thousand eight hundred and seventy-nine.

A. M. CLARK. (L.S.)

LONDON: Printed by George Edward Eyre and William Spottiswoode,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.

1879.